“The Proper Shape for Rock Drill Bits”

Written for *Mine and Quarry* by D. J. O’Rourke, Claremont, New Hampshire

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The article begins:

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THE PROPER SHAPE FOR ROCK DRILL BITS.

WRITTEN FOR "MINE AND QUARRY"

By D. J. O'Rourke.*

Much attention is paid to the mechanical details of drilling machines at the time of their purchase, to secure those which will be most efficient in the amount of power used and in cost for maintenance. Too often, this is as far as the user's interest goes. Having procured a good drill, he does not take steps to secure the very best working efficiency from it.

The question of drill steel, its selection, care, and use, is one which is given far too little attention, and which in many cases is the determining factor as to the economic success of a drilling plant. If the steels are of good materials, carefully made, sharpened and tempered for the work to be done, and if fresh steels are put into use as soon as the gauge begins to wear, the drills will come up to expectations as to speed and efficiency; but if the blacksmith is incompetent and the drill runner careless, the management could better afford to throw out its machines and go back to hand drilling.

THE BLACKSMITH.

The blacksmith's work should be recognized as almost equal in importance to that of the master mechanic at a drilling plant. The best smith is none too good, even if there should not be enough work to justify the wages he may demand. It is cheaper to have a blacksmith and helper idle once in a while than to have two or three drill runners and their helpers standing around watching the drills wearing themselves to pieces, and perhaps helping them along with a sledge hammer, while the drills fail to give results, merely because the bits are not right. There are also other men on the premises shoveling away dollars in the shape of coal, and this too must be taken into account. When it is all summed up, the idle time of the blacksmith and helper is an insignificant item.

When a new compressor plant is installed, every feature, whereby a pound of coal or an extra foot of air may be saved or made is investigated, and every precaution taken to secure economical results. After the plant is running, the drilling, which was at all times the main object, is sometimes allowed to run along in such a way that anywhere from 10 to 50 per cent. of the power developed is completely lost. No one would think of allowing a hoisting engine to hoist a load with the brakes partially set, but something similar occurs when a rock-drill bit is run so long that it is the same gauge for an inch or more back of its cutting edge, or is allowed to be made with shoulders on it in the first place.

SHAPE OF THE BIT.

For drilling rock of any kind, the cross-bit, made like Figures 1, 2, 3, and 4, sometimes modified to the X shape shown in Figure 5, is usually employed. It will be observed that the bits above referred to are made concave with the corners of the wings ahead of the center. This design is recommended because used bits show very little wear at the center as compared with their outer edges. This indicates that the corners do the largest part of the work. The cutting done by them so weakens the rock toward the center of the hole that it does not afford so much resistance to the center of the bit.

Figures 8, 9, and 10 show what actually takes place in fracturing the rock with bits of several shapes. Figure 8 shows the concave bit, whose corners cut ahead of the center, making the line of breakage very weak and leaving little resistance for the center of the bit, as described above. Figure 9 illustrates a convex bit. In this, the center has to cut ahead of the corners. The fracture line is thus divided, leaving but little work for the corners to

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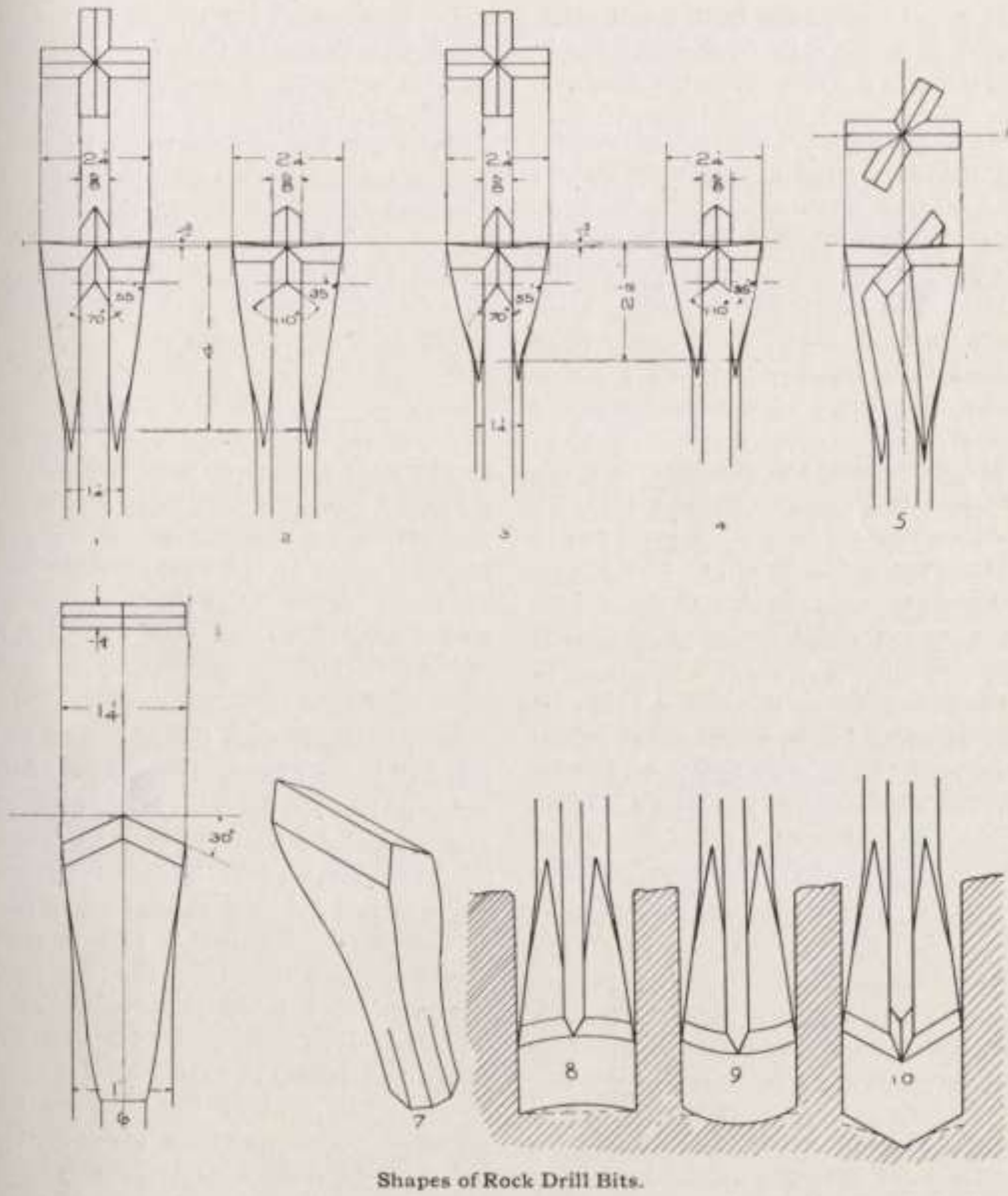

Shapes of Rock Drill Bits.

do. The cross shape of the center, together with the increased amount of work which falls upon it, in this case, greatly retards its cutting efficiency. Figure 10, the diamond-pointed bit, also divides the fracture line, but at the same time increases its length, leaving less cutting for the center. With this bit, the rock tends to break to a flatter angle than the angle of the bit, allowing the center to go in advance of the corners for a few blows, when the entire bit again comes in contact with the rock, fracture again takes place, and the process described above is repeated. This bit is recommended only for marble, soft limestone, and other even, soft rocks. Its advantage for this work lies in the fact that nearly all drilling in quarries is done on laid-out lines, so that this form enables the holes to be started accurately. The bit, however, is made very thin and is not strong enough to be satisfactory on general mining and contract work. The flat, or "bull" bit, as it is sometimes called, shown by Figure 7, is made in various shapes, but no matter how it is made its use is very severe on a rock drill. If thin, it has no reaming qualities; if made heavy, as it generally is, the blow delivered imparts a severe jar to the machine. The flat bit, with diamond point, Figure 6, is a style which has been used in marble quarries from the earliest introduction of the rock drill. The steam pressure used in those days was considerably lower than now, so that this bit was satisfactory, and cut slow enough to ream the holes fairly well. Even under these conditions it was hard on the rotating device, but when higher pressures were introduced its cutting capacity was increased, while its reaming qualities remained the same. The flat bit may cut more rapidly for a short time, but in the long run the cross will be found more economical. The use of the X bit, Figure 5, is not general, but sometimes is desirable when a cross-bit will persist in drilling "rifled" or five-fluted holes on rock of some kinds. Sometimes rifling is charged to the machine, but the fact that the X bit is not required on all kinds of rock rather disproves this imputation.

SHARPENING THE BITS.

Figures 1 and 2 are bits for hard, non-gritty rock, and are alike except for the different angles shown on the cutting edges. Figure 1 shows about the highest angle to which the cutting edge can be made without danger of breaking. The angle shown on the cutting edge in Figure 2 is one of many which may be used under different conditions, without any other change in the bit. In cutting hard and medium hard rock, sharp drills and a wide-open throttle may be used to good advantage, and the hole will not ordinarily clog with mud, as the amount of rock loosened by each blow is so little that it is at once mixed into slush by the water in the hole. The sharp rebound of the drill when striking hard rock, together with the positive recovery of the machine, quickly gets rid of this slush. If the same bits and drill are run on an open throttle in soft or even medium soft ground, the hole soon becomes clogged. The reason for this is that while the hole remains of the same diameter, and the amount of water for mudding purposes is therefore the same, the steel chips out three or four times as much dust at each blow as it does in hard rock. The rate of cutting should therefore be reduced in order to keep the drill working at maximum efficiency. The speed may be regulated by throttling the air or steam, but this reduces the rapidity of action of the drill, so that it does not always mix into slush the dust caused at even the slower speed. The recoil of the steel from soft rock is also considerably less. In soft rock duller bits should be used, like that shown in Figure 4. The angle of the cutting edge may be even higher than this, sometimes almost square on the end, in order to secure good results.

LENGTH OF UP-SET.

In connection with the above subject, it is well to bear in mind the length of the wings or ribs for different kinds of work. Figures 1 and 2 show an extreme length for very hard rock, intended to give strength and hold the gauge as long as it is necessary. Figures 3 and 4 show shorter ribs which give the bit more clearance and make it more desirable for general purposes. Under ordinary conditions its ability to mix mud is much greater than that of the long bit like Figure 1. This shortness gives greater flare to the wings, causing a greater backward thrust to be given the cuttings, whether wet or dry. In rock which wears the gauge rapidly, however, the up-set should be longer. For drilling dry holes in tunnel headings or elsewhere the bit with short ribs has less tendency to allow the hole to draw up. The friction of this style of bit retards the machine but little, and will cause it to cut down toward the lower side of the hole, thereby straightening it. If this is done in time, it saves frequent drops of the arm and keeps the hole where it is wanted. It will be found on experiment that such results cannot be gotten if a long bit with very slight clearance is used. The wings are five-eighths of an inch thick for the size shown in Figures 1 to 4, and should never be less than that for this size of bit and steel. They should be the same thickness throughout to allow free return of the cuttings. If gauge less than two and one-quarter inches is desired, make the bit correspondingly shorter.

GAUGE.

It should be especially noted that in all the sketches the outer edges of the wings are square. This feature is very important, to preserve the gauge of the hole. Whether the bits are sharpened by machine or by hand, care should be taken that no bits are made with the outside edges made rounding like a figure 8. The question of maintaining the gauge of the hole throughout its length is very important. It should be carefully determined just how much work each drill bit will do before the gauge begins to wear. In the hardest rocks a bit is never in condition to use the second time, and from 24 inches to 30 inches, depending on the length of the feed, is all that is ever attempted. Sufficient steel is therefore supplied, so that a sharp set is on hand for each hole. In softer rock and ore it frequently happens that the steel will not become dull even if used on several holes. Drill runners are, therefore, apt to disregard the question of the gauge so long as the cutting edge is sharp. The gauge, however, causes the rub in more than one sense. This is where the rub comes in that retards the work of the drills, shortens their life, consumes power, and increases the repair bills. For example, on this kind of rock a runner is given two sets of sharp steel to drill a required depth. Each set will drill perhaps two holes each without making trouble. About the third hole on which this steel is used the bits stick and there is a constant demand for a hammer or a chuck wrench with which to beat the steel, and if the right point of humor is reached there is no discrimination shown between the steel and drill piston. Here is a drill that worked all right on the first hole, fairly well on the second, and will not work at all on the third. The rock is the same and the drill is the same, but not so the bits. The only sharp bit that can be gotten into that hole must be made specially in the blacksmith shop half a mile away, so the hammering is kept up and the drill finally worked down somehow, taking usually more time than it took to put in the first two.

When the gauge wears so that a new steel is needed in order to insure its following the last, an entirely new set should be used. It makes no difference if one of the bits still appears good, for it is economical not to waste time with it. On any rock on which the cutting edges are not dulled upon the first hole, a system should be devised by the foreman or superintendent to determine how much each bit will do without too much "hammer help." The improvement will be very pronounced. The runner or blacksmith should have nothing to say as to this system. The blacksmith should have rigid instructions to furnish all bits to the exact gauge required, so that the new bits will work freely when placed in the hole. Much time is wasted from the fact that bits are not made exactly to gauge to begin with.

Users of mechanical drill sharpeners are advised to give thought and care to securing the proper dies and dollies to make bits suitable to the conditions under which they are to be used; also that when drills are being dollied the dies do not open. Some rather impossible-looking bits are occasionally seen for this reason alone.

TEMPER.

The matter of tempering bits is another point in which the blacksmith can save or waste much drilling time to his employers. A competent blacksmith will furnish bits of the precise temper, to suit the rock being drilled.

Duty on Diamond Drill Carbon.

The extensive use of Diamond Prospecting Core Drills in the United States renders of especial interest to the mining industry, a case now before the New York customs officials, for decision. Until about a year ago, black diamonds for diamond drilling and other commercial uses were admitted to this country, duty free, being classed as uncut stones for mining and industrial purposes.

The customs officials now in office at New York have decided, however, that while black diamonds in the natural or unbroken state, may be admitted free, stones split abroad are by this process, rendered more valuable and are therefore subject to duty. A tariff of 10 per cent *ad valorem* has, for the past twelve months, been in force on this class of carbon. This duty enables the carbon dealers to charge at least 10 per cent more for carbon than would otherwise be the case, thereby materially increasing the cost of diamond drill work to the consumer.

The Sullivan Machinery Company, which is the largest manufacturer of Diamond Drills, and also a large operator of these machines, for contract drilling, is one of the heaviest buyers of carbon from dealers in New York, London and Paris. It demands stones of the highest grade, not only for its individual use, but for that of its customers, many of whom prefer to trust to its knowledge and experience in the selection of stones, rather than to buy direct from dealers. This company, in the interest of all users of diamond drills, as well as in its own, has recently registered a protest against this tariff. A test case, involving the payment of duty on a parcel of broken stones from England, was brought before the appraiser in New York City about ten weeks ago. The plaintiff demonstrated that black diamonds were a natural product, not found or produced in the United States, but only discovered in a certain part of Brazil, consequently that the tariff could not be justified on the ground of protecting an American industry; also that unbroken stones were of no value whatever for drilling until reduced by splitting to suitable sizes; and that for this reason, broken stones were no more valuable than unsplit carbon of proper size for immediate use, which are now, and always have been, admitted free. It was also shown that original parcels, containing both natural and broken diamonds are sold in Europe to American importers at a flat price, whether they are suitable for use with or without splitting.

The customs officials endeavored to show, by the evidence of New York carbon dealers, that broken stones command a higher price in this country than the natural variety, but no specific instances were brought out in which split stones had been sold or quoted at a higher price than natural stones of the same weight and quality. On the other hand, letters from these New York dealers were placed in evidence by the plaintiff, in which the same quotation had been made on both classes of carbon shipped mixed together in the same parcel.

The plaintiff made a strong point of the fact that the tariff was of no value to any concern or industry in the United States, but was rather a burden and a restriction upon the entire mining industry. Mexico and Canada have always admitted carbon free, under the name of "Miner's Diamonds" and in the case of Canada, Diamond Drills are admitted free, the Government holding that they perform a valuable office in the development of the mineral resources of that country, while nearly every other class of mining machinery manufactured in the United States is assessed 27½ per cent. *ad valorem* for entry into Canada.

The test case above referred to, is now under consideration by the Board of Appraisers and it is hoped that their decision, which is expected shortly, will result in revoking the duty on black diamonds.